

IN THE CLAIMS:

1. (Currently Amended) A lithographic projection apparatus comprising:  
a radiation system that provides a ~~projection~~ beam of radiation;  
a support structure that supports patterning structure, the patterning structure serving to pattern the ~~projection~~ beam according to a desired pattern;  
a substrate table that holds a substrate;  
a projection system that projects the patterned beam onto a target portion of the substrate; and  
a displacement measuring system that measures the position of a moveable object, comprising one of said support structure and said substrate table, in at least two degrees of freedom, said displacement measuring system comprising at least one grid grating mounted on said moveable object and at least one sensor head that measures displacements of said grid grating in at least two degrees of freedom,  
wherein the or each said grid grating is positioned so as to be substantially coplanar with a functional surface of said patterning structure supported by said support structure or a substrate held by said substrate table.
2. (Currently amended) An Apparatus apparatus according to claim 1 wherein said displacement measuring system comprises two grid gratings mounted on said moveable object at spaced apart locations and two sensor heads each to measure displacements of a respective one of said grid gratings.
3. (Currently amended) An Apparatus apparatus according to claim 1 wherein the or each said grid grating is incorporated directly into the main body of said moveable object.
4. (Currently amended) An Apparatus apparatus according to claim 2 wherein the or each said grid grating is incorporated directly into the main body of said moveable object.
5. (Currently amended) A lithographic projection apparatus comprising:  
a radiation system that provides a ~~projection~~ beam of radiation;

a support structure that supports patterning structure, the patterning structure serving to pattern the ~~projection~~ beam according to a desired pattern;

a substrate table that holds a substrate;

a projection system that projects the patterned beam onto a target portion of the substrate; and

a displacement measuring system that measures the position of a moveable object, comprising one of said support structure and said substrate table, in at least two degrees of freedom, said displacement measuring system comprising at least one grid grating mounted on a reference frame and at least one sensor head mounted on said moveable object that measures displacement of said moveable object relative to said grid grating in at least two degrees of freedom.

6. (Currently amended) An Apparatus apparatus according to claim 1 wherein said moveable object is moveable in a first direction for scan imaging and the or each said grid grating has a length in said first direction greater than or equal to the range of motion of said moveable object in said first direction.

7. (Currently amended) An Apparatus apparatus according to claim 2 wherein said moveable object is moveable in a first direction for scan imaging and the or each said grid grating has a length in said first direction greater than or equal to the range of motion of said moveable object in said first direction.

8. (Currently amended) An Apparatus apparatus according to claim 3 wherein said moveable object is moveable in a first direction for scan imaging and the or each said grid grating has a length in said first direction greater than or equal to the range of motion of said moveable object in said first direction.

9. (Currently amended) An Apparatus apparatus according to claim 5 wherein said moveable object is moveable in a first direction for scan imaging and the or each said grid grating has a length in said first direction greater than or equal to the range of motion of said moveable object in said first direction.

10. – 13. (Cancelled)

14. (Currently amended) An Apparatus apparatus according to claim 5 wherein the or each said grid grating is positioned so as to be substantially coplanar with a functional surface of said patterning structure supported by said support structure or a substrate held by said substrate table.

15. (Currently amended) An Apparatus apparatus according to claim 1, wherein said displacement measuring system further comprises a memory constructed and arranged to store correction information representing differences between the or each grid grating and an ideal grid grating and a data processing means constructed and arranged to correct measurements output by the or each sensor head.

16. (Currently amended) An Apparatus apparatus according to claim 1, wherein said displacement measuring system further comprises one or more capacitive or optical sensors constructed and arranged to measure the position of said moveable object in degrees of freedom not measured by the or each grid grating and sensor head.

17. (Currently amended) An Apparatus apparatus according to claim 1, wherein the or each grid grating includes a reference mark detectable by the respective sensor head to define a reference position of said moveable object.

18. (Currently amended) An Apparatus apparatus according to claim 1, wherein the or each sensor head comprises an encoder head.

19. (Currently amended) An Apparatus apparatus according to claim 1, wherein said displacement measuring system further comprises an interpolator constructed and arranged to interpolate the output of the or each sensor head.

20. (Currently amended) An Apparatus apparatus according to claim 1, wherein the support structure comprises a mask table that holds a mask.

21. (Currently amended) An Apparatus apparatus according to claim 1, wherein the radiation system comprises a radiation source.

22. (Currently Amended) A device manufacturing method comprising ~~the steps of~~:

providing a substrate that is at least partially covered by a layer of radiation-sensitive material, said substrate being supported by a substrate table;

providing a projection beam of radiation using a radiation system;

using patterning structure to endow the projection beam with a pattern in its cross-section, said patterning structure being supported by a support structure;

projecting a patterned beam of radiation onto a target portion of the layer of radiation-sensitive material; and

measuring displacements of one of said support structure and said substrate table in at least two degrees of freedom using at least one grid grating mounted thereon and at least one sensor head,

wherein said at least one grid grating is positioned so as to be substantially coplanar with a functional surface of said patterning structure or the substrate.

23. (Original) A device manufactured according to the method of claim 22.

24. (Currently Amended) A method of calibrating a lithographic projection apparatus comprising ~~the steps of~~:

providing a patterning structure, having a reference pattern, held in a moveable support structure, said reference pattern having a plurality of reference marks at pre-calibrated positions in at least a scanning direction of the lithographic projection apparatus;

holding an image sensor on a substrate table at a constant position relative to ~~the a~~ projection system;

positioning said moveable support structure so as to project an image of each of said reference marks in turn onto said image sensor; and

measuring the position of said moveable support structure using at least one grid grating mounted thereon and at least one sensor head in at least a first degree of freedom when each of the reference marks is projected onto said image sensor,

wherein said grid grating is positioned so as to be substantially coplanar with a functional surface that includes said reference pattern.

25. (Original) A method according to claim 24 wherein said image sensor is positioned under the center line of the projection system.

26. (Previously presented) A method according to claim 24 wherein the image sensor is positioned at an extreme position of the exposure field of the projection system.

27. (Cancelled)

28. (Currently amended) An Apparatus apparatus according to claim 5, wherein said displacement measuring system further comprises a memory constructed and arranged to store correction information representing differences between said at least one grid grating and ideal grid grating and a data processing means constructed and arranged to correct measurements output by the or each sensor.

29. (Currently amended) An Apparatus apparatus according to claim 5, wherein said at least one grid grating includes a reference mark detectable by the respective sensor head to define a reference position of said moveable object.

30. (Currently amended) An Apparatus apparatus according to claim 5, wherein said at least one sensor head comprises an encoder head.

31. (Cancelled)

32. (Previously presented) A device manufacturing method according to claim 22, wherein said at least one grid grating is mounted to a reference frame and said at least one sensor head is mounted on said moveable object.

33. (Previously presented) A device manufacturing method according to claim 22, further comprising correcting measurements output by said at least one sensor head according to correction information representing differences between said at least one grid grating and an ideal grid grating.

34. (Previously presented) A device manufacturing method according to claim 22, further comprising detecting by said at least one sensor head a reference mark of said at least one grid grating to define a reference position of said moveable object.

35. (Cancelled)

36. (Previously presented) A device manufacturing method according to claim 22, comprising moving said moveable object in a first direction for scan imaging and wherein said at least one grid grating has a length in said first direction greater than or equal to the range of motion of said moveable object in said first direction.

37. (Previously presented) A device manufacturing method according to claim 22, wherein said at least one sensor head comprises an encoder head.

38. (Currently amended) A lithographic projection apparatus comprising:  
a radiation system that provides a ~~projection~~ beam of radiation;  
a support structure that supports patterning structure, the patterning structure serving to pattern the ~~projection~~ beam according to a desired pattern;  
a first substrate table that holds a first substrate;  
a second substrate table that holds a second substrate;  
a projection system that projects the patterned beam onto a target portion of at least one of the first substrate and the second substrate; and

a displacement measuring system that measures the position of a moveable object, comprising one of said support structure, said first substrate table and said second substrate table, in at least two degrees of freedom, said displacement measurement system comprising at least one grid grating mounted on said moveable object and at least one encoder head that measures displacements of said grid grating in at least two degrees of freedom,

wherein said at least one grid grating is positioned so as to be substantially coplanar with a functional surface of said patterning structure supported by said support structure, said first substrate held by said first substrate table or said second substrate held by said second substrate table.

39. (Currently amended) An Apparatus apparatus according to claim 38, wherein said moveable object is moveable in a first direction for scan imaging and said at least one grid grating has a length in said first direction greater than or equal to the range of motion of said moveable object in said first direction.

40. (Cancelled)

41. (Currently amended) An Apparatus apparatus according to claim 38, wherein said displacement measuring system comprises two grid gratings mounted on said moveable object at spaced apart locations and two encoder heads each to measure displacements of a respective one of said grid gratings.

42. (Currently amended) A lithographic projection apparatus comprising:  
a radiation system that provides a ~~projection~~ beam of radiation;  
a mask table that holds a mask serving to pattern the ~~projection~~ beam according to a desired pattern;  
a first substrate table that holds a first substrate;  
a second substrate table that holds a second substrate;  
a projection system that projects the patterned beam onto a target portion of at least one of the first substrate and the second substrate; and  
a displacement measuring system that measures the position of said mask table in at least two degrees of freedom, said displacement measurement system comprising at least one grid grating mounted on said mask table and at least one encoder head that measures displacements of said grid grating in at least two degrees of freedom,  
wherein said at least one grid grating is positioned so as to be substantially coplanar with a functional surface of said mask.

43. (Currently amended) An Apparatus apparatus according to claim 42, wherein said displacement measuring system comprises two grid gratings mounted on said mask table at spaced apart locations and two encoder heads each to measure displacements of a respective one of said grid gratings.